



SWTEST
2026 CONFERENCE

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Resolving the contact dilemma

An industrialized framework for ultra-fine pitch wafer test using μ 3D printed probes

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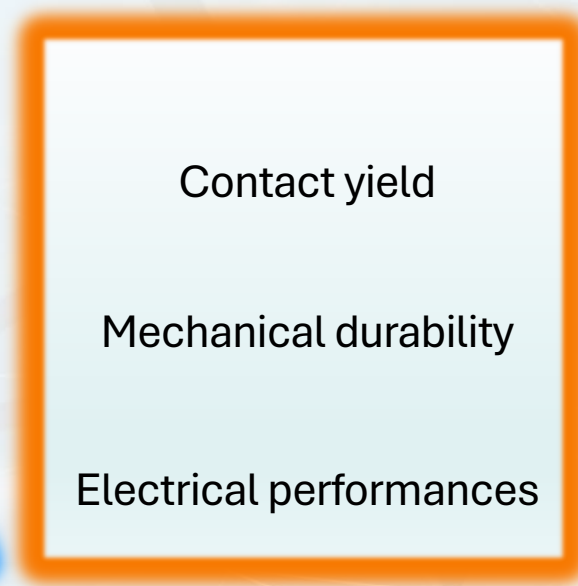
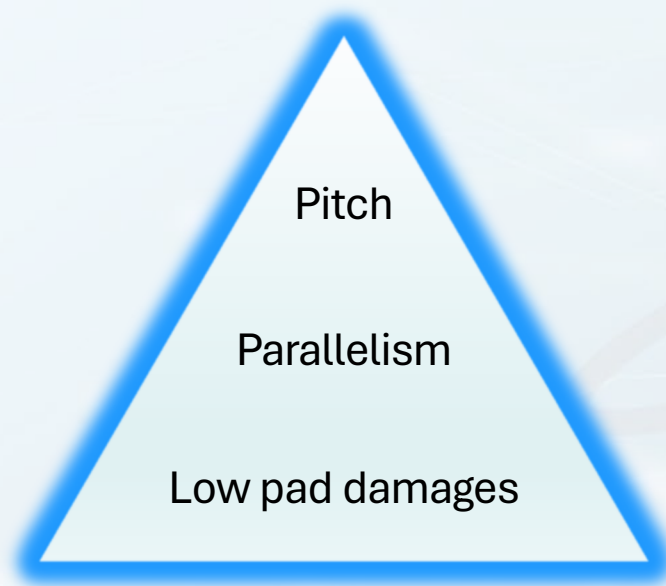
Booth: 414

Francesco Colangelo, Wabe Koelmans,
Edgar Hepp, Patrik Schürch

EXADDON AG

The contact dilemma

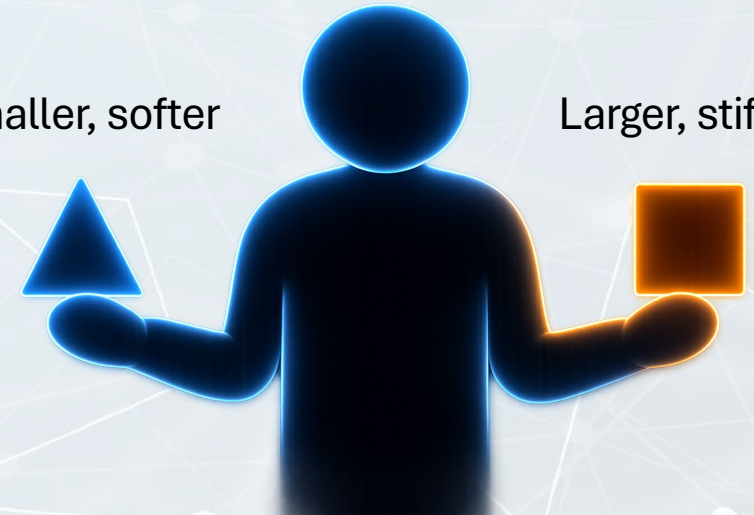
Testing requirements



Which probe?

Smaller, softer

Larger, stiffer



Why now?



MicroLED

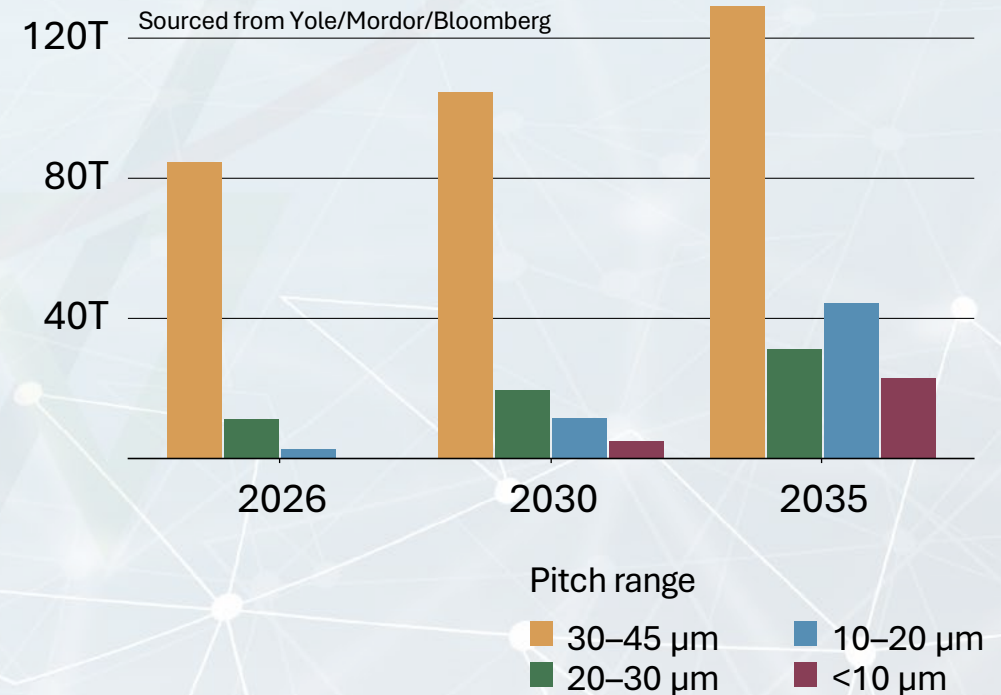
Small pads and pitch
Massive parallel testing needed
Highly sensitive to pad damage



AI / HPC packaging

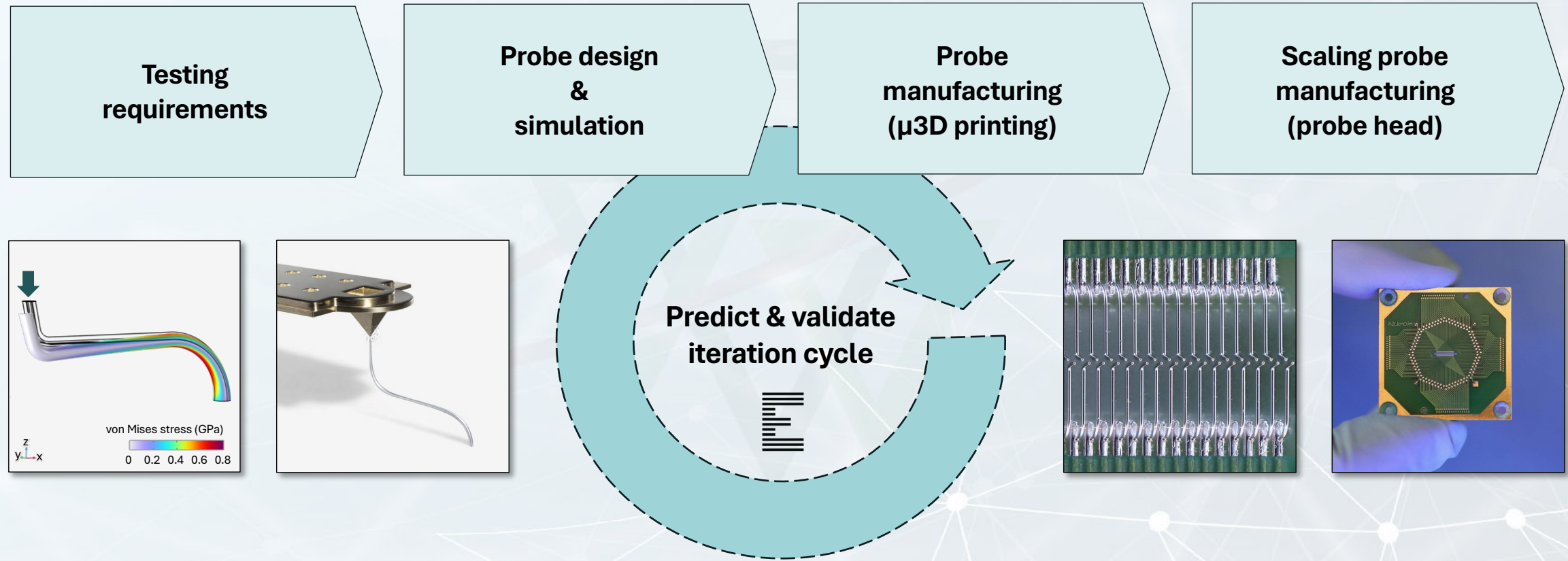
Exploding I/O density
Transition toward ultra-fine pitch
micro-bumps

Pads produced by pitch range (est.)



Testing: the next bottleneck

Optimization framework



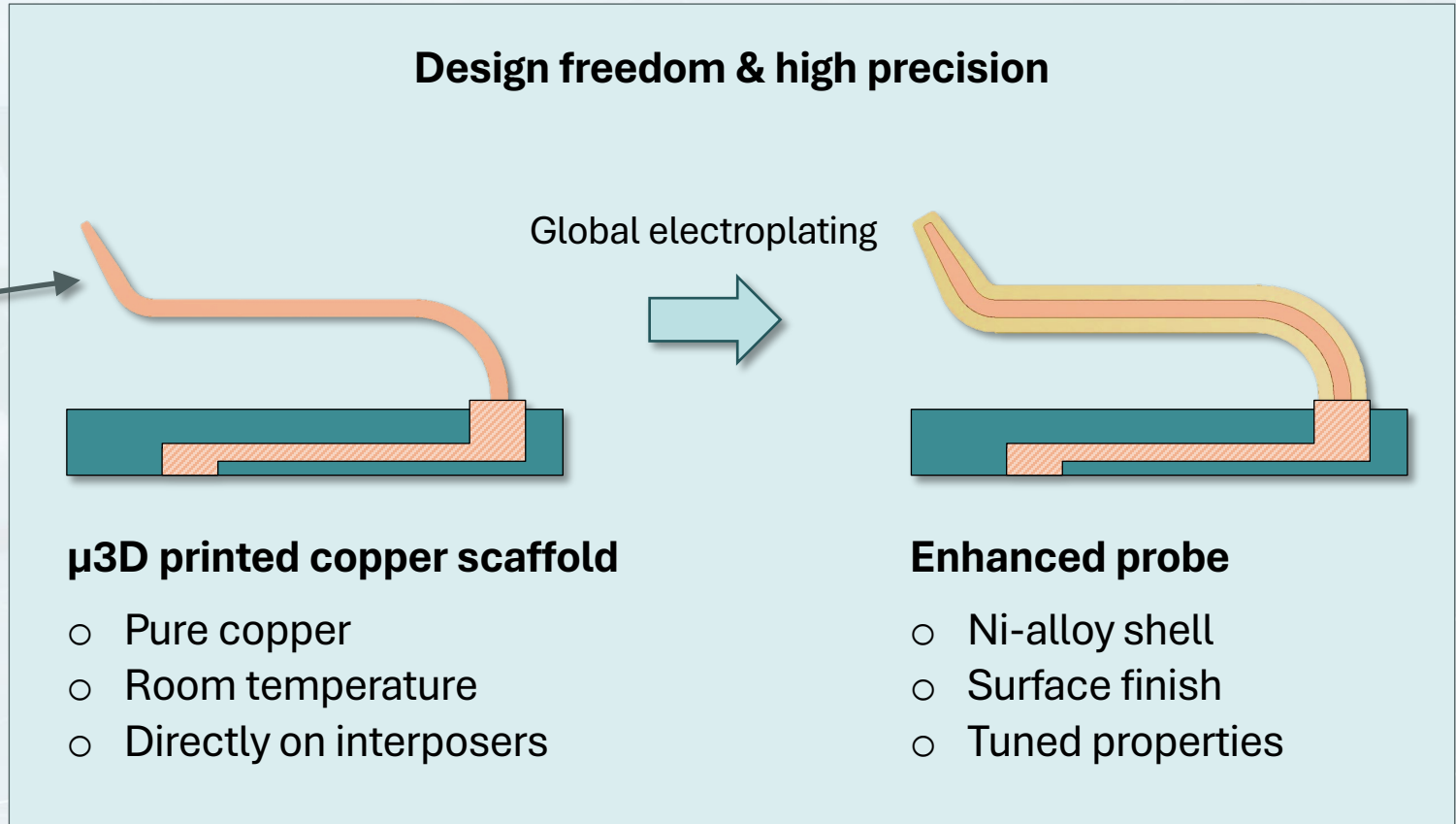
Rapid, application-specific probe optimization

(i) Probe manufacturing

Metal μ 3D printer



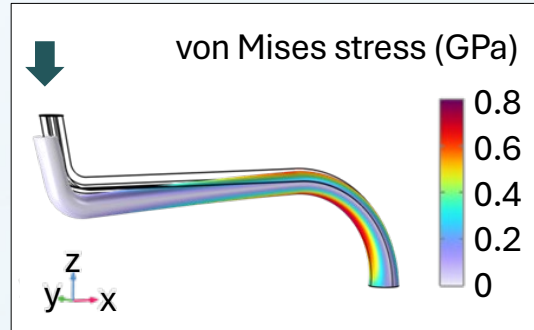
Design freedom & high precision



From concept to functional probe in a quick manufacturing process

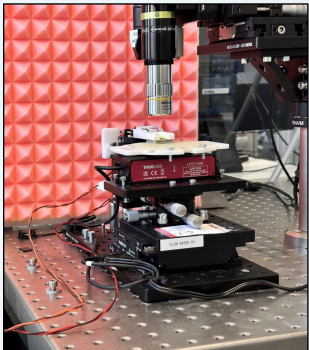
(ii) Predict & validate

Predictive design

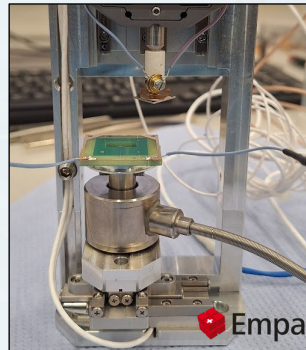


Tools

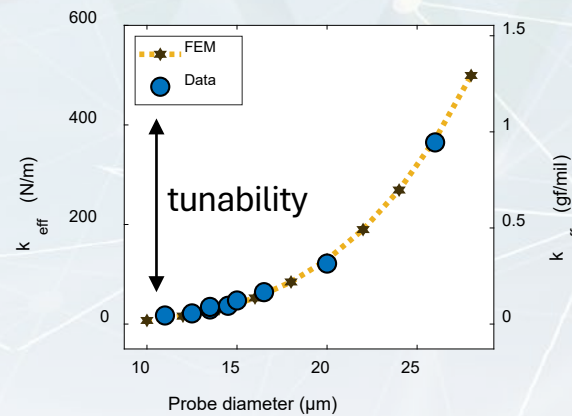
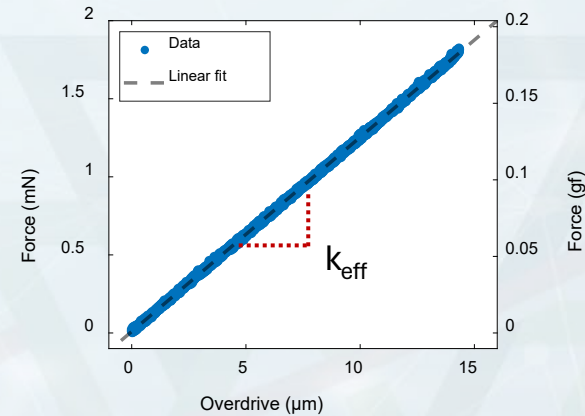
Custom prober



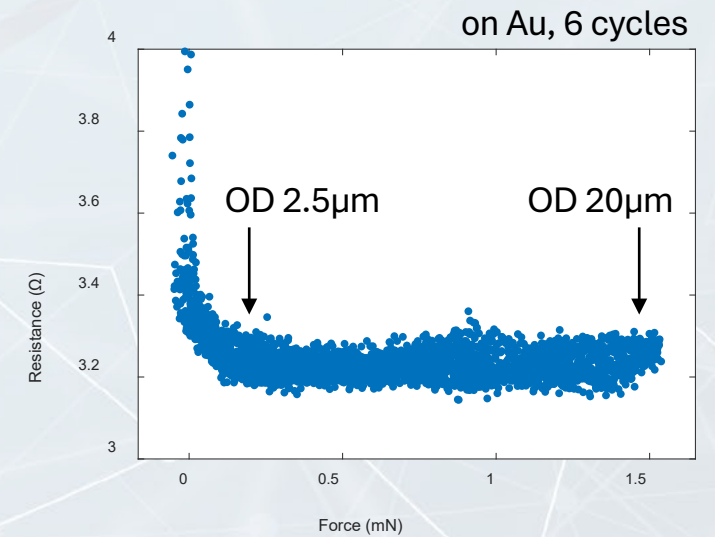
In-situ nano-indenter



Mechanical tests



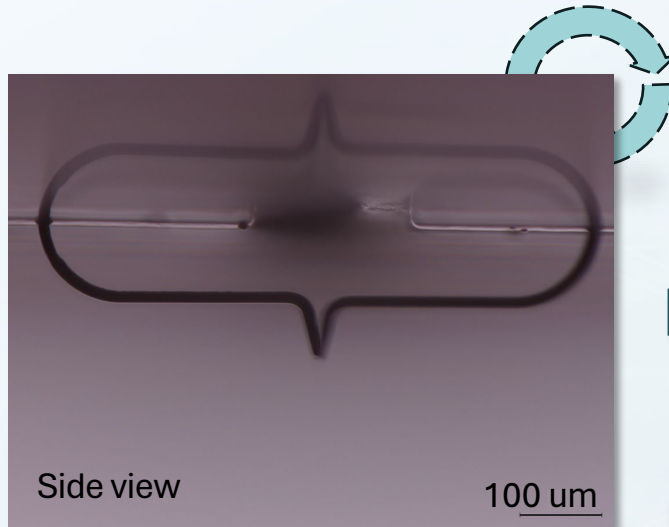
Electro-mechanical performances



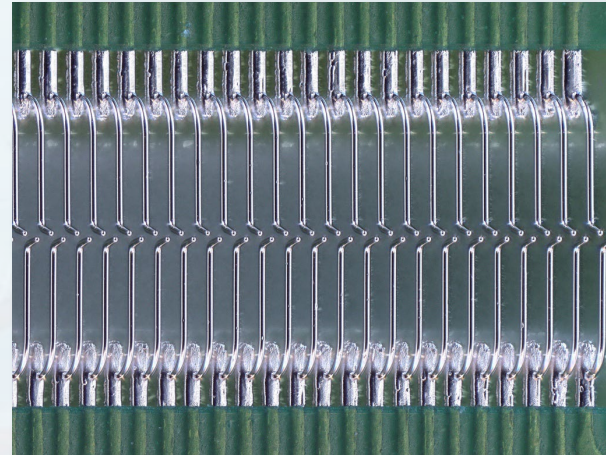
Know-how build up

(iii) Scaling to probe heads

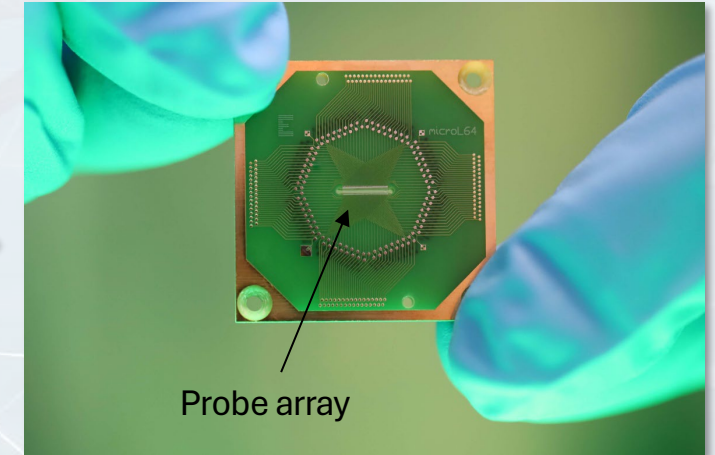
Optimized probes



Array fabrication on fan-out substrate

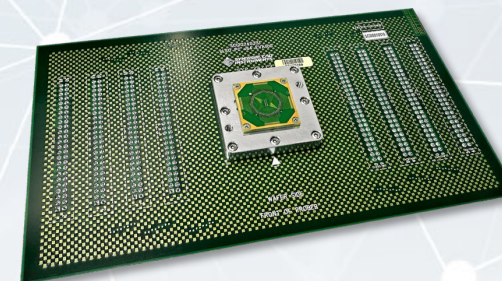


Probe head

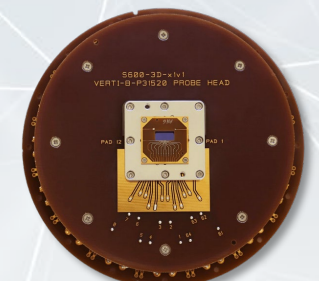


State-of-the-art precision: Direct μ 3D printing $\rightarrow$ μ m-level accuracy
Modular architecture: Easy to replace probe heads
Industrial scalability: From prototype to fully integrated probe cards

MicroLED probe card

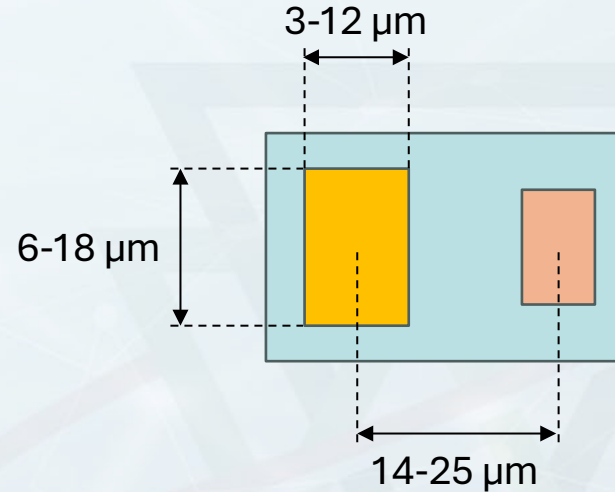
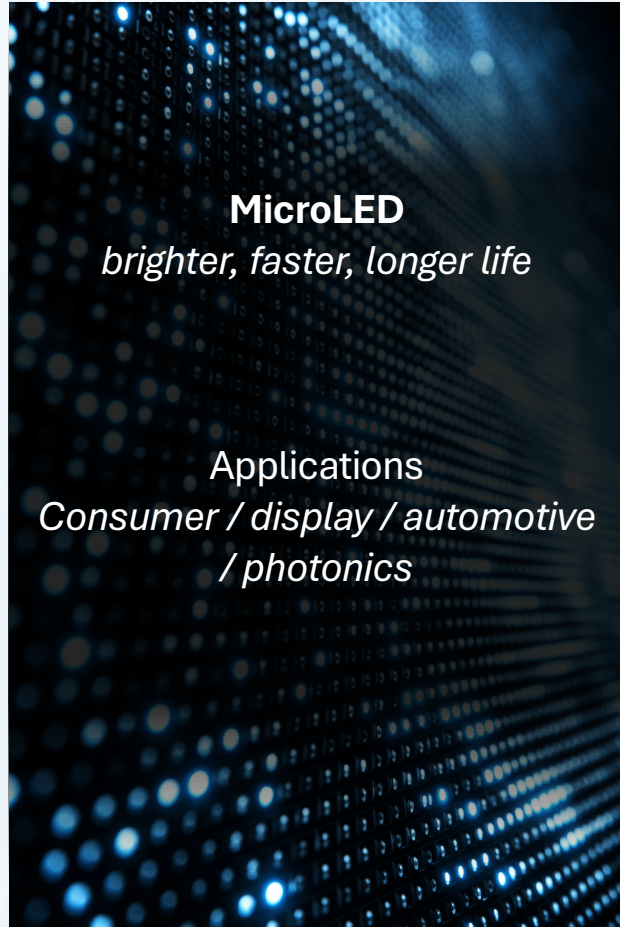


Parametric test probe card



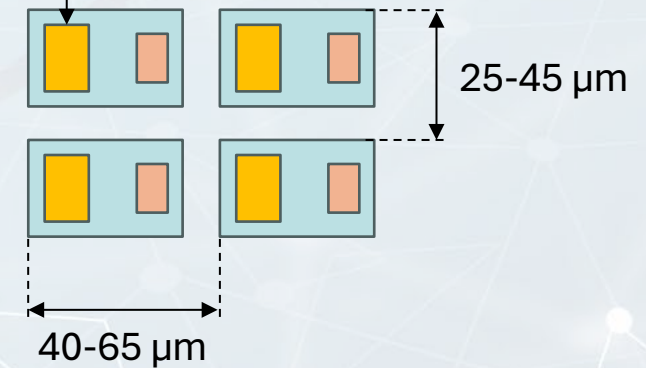
Ultra-fine pitch microLED probe card

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Testing & bonding pads

Sensitive to damage (e.g. Au, ITO, Sn)



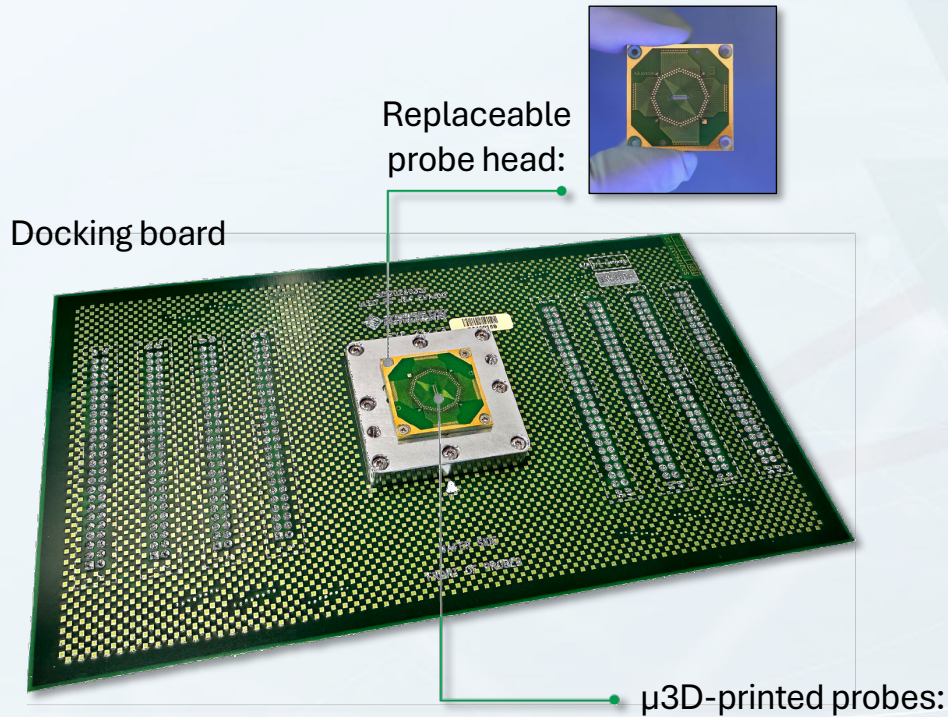
Non-invasive:
High parallelism:
Electrical precision:
Statistical sampling:

Calibrated force
 μm -level accuracy over several mm
Low leakage & stable contact
High yield and uniformity mapping

Full control over probe shape & placement are key enablers for massive microLED testing

MicroLED probe card – *microL64*

microL64: 64 DUT parallel

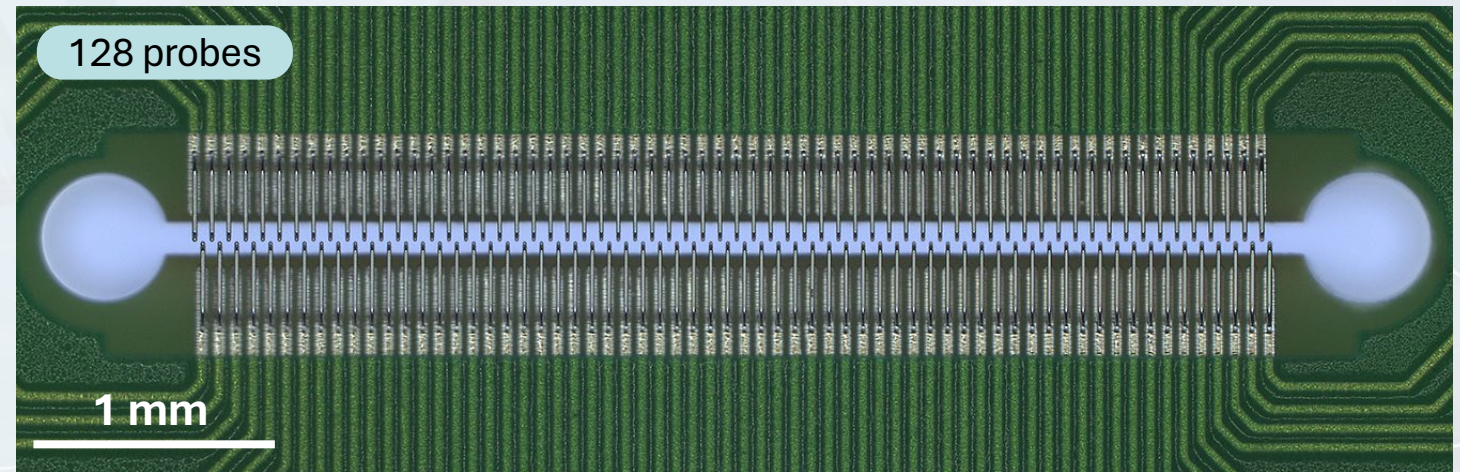


64x speed
testing increase

Minimize
pad damages

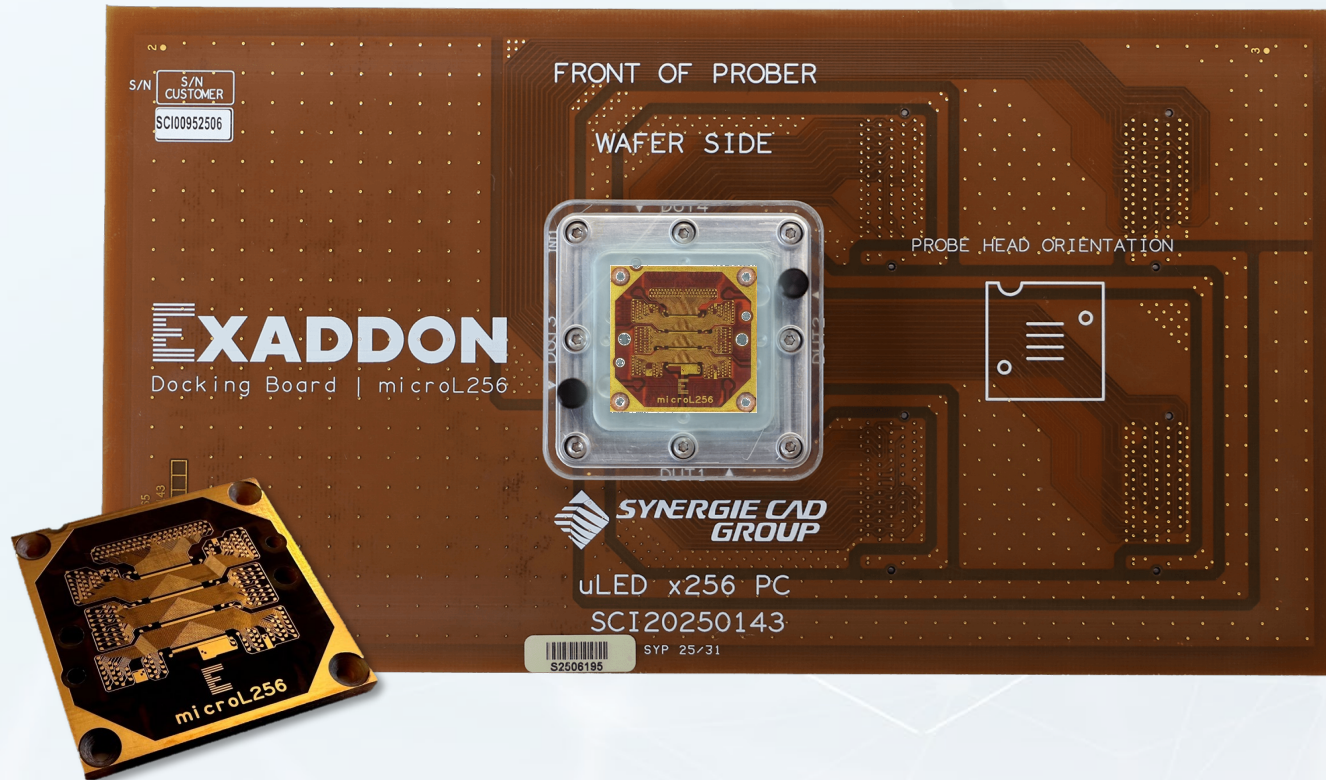
Ultra-fine pitch
< 20 μm

Low downtime
and delays



MicroLED probe card 2.0

microL256: 256 DUT parallel



All *microL64* features

+

Higher parallelism

- up to 256 DUT (512 probes)

Enable reverse current tests

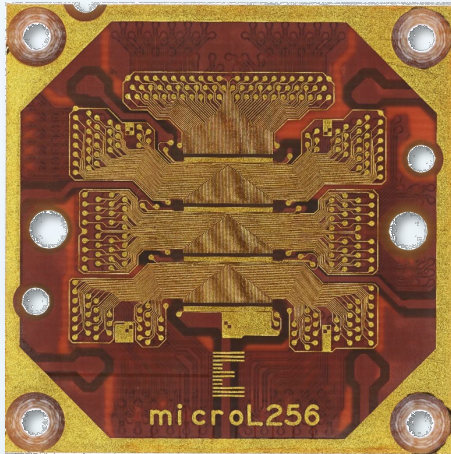
- sub-100pA noise floor

Wafer sampling option

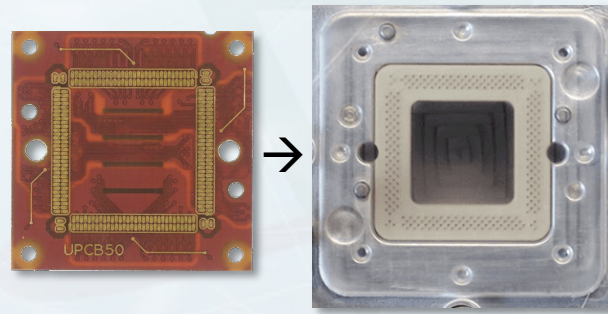
- customizable layout

microL256 architecture

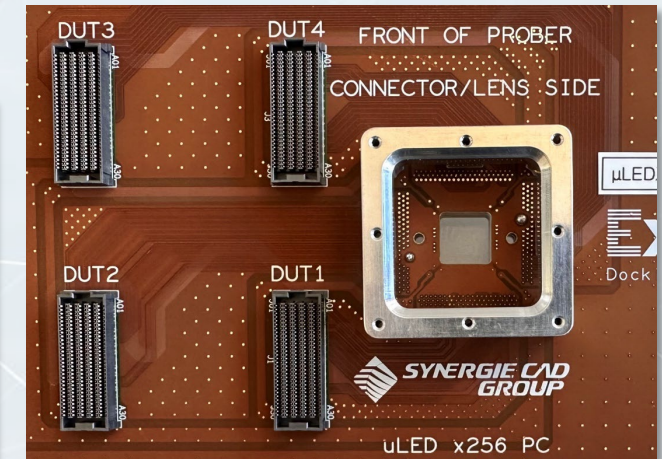
Low-leakage
256 DUT probe head



Probe head backside
contacts → docking board
pogo pins



Low-leakage specialized
board, cables and connectors



Modularity
Reduced downtime

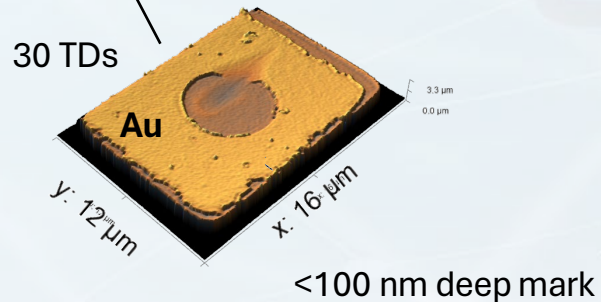
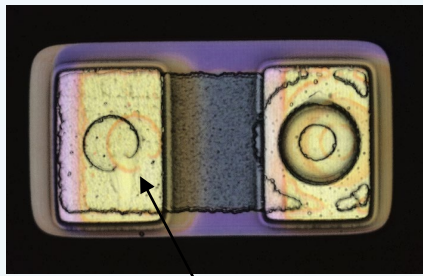
Multiple wafer layouts or sampling configurations enabled
Faster probe head swaps and simplified maintenance

A flexible architecture enabling scalable and maintainable wafer test solutions

MicroLED probe card performances

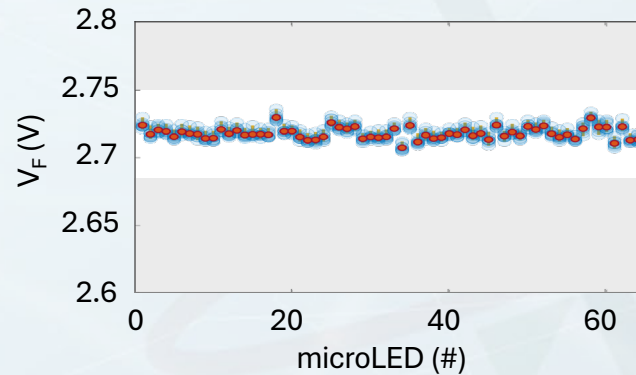
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Negligible scrub mark



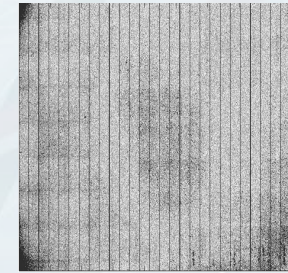
Accuracy and reliability

200 TDs, same location



Enabling wafer mapping

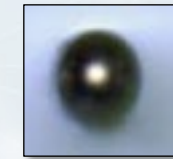
Vf of 3.2M microLEDs



Testing speed: >1M per hour

Longevity

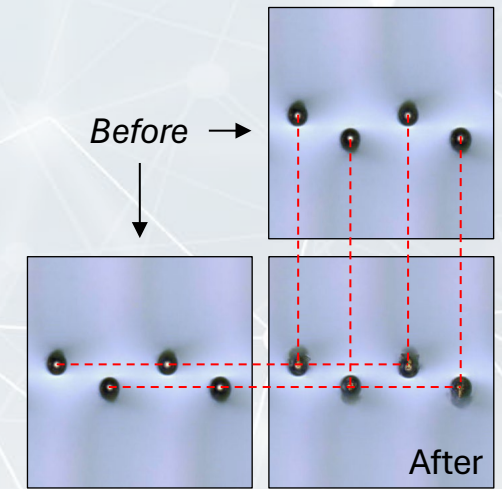
10M microLED*



Before



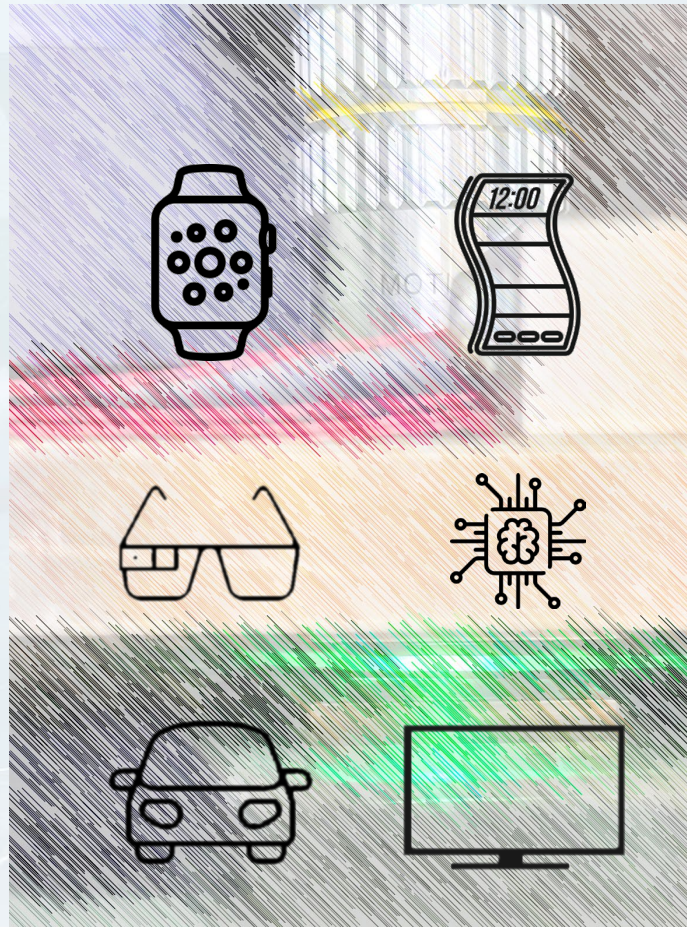
After



*no-cleaning involved

**Universal probe properties proven
and refined on real devices**

MicroLED full testing solution



MicroLED probe card

Enable in-line electrical probing at the wafer level

- Non-invasive tests
- Ultra-fine pitch capabilities
- Smart design

Turn wafers into insights

Partnership & projects



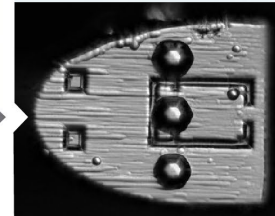
TERADYNE



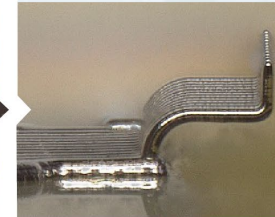
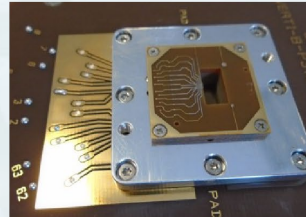
ADVANTEST®



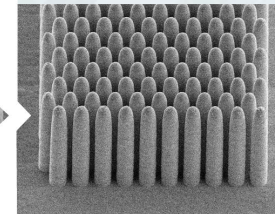
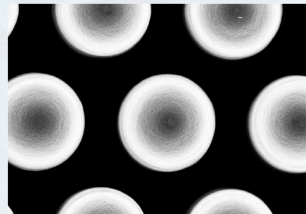
MPI CORPORATION



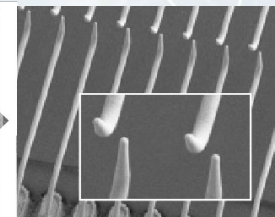
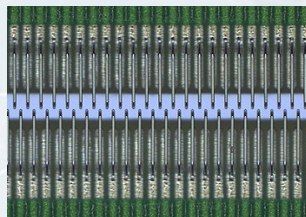
Ultra-low losses 50 GHz probe
< 50µm pitch
Unique full coax shielding until the pads



High-performance parametric test
Ultra-low background current (< 1 fA/V)
Targeting small pads (30 µm)

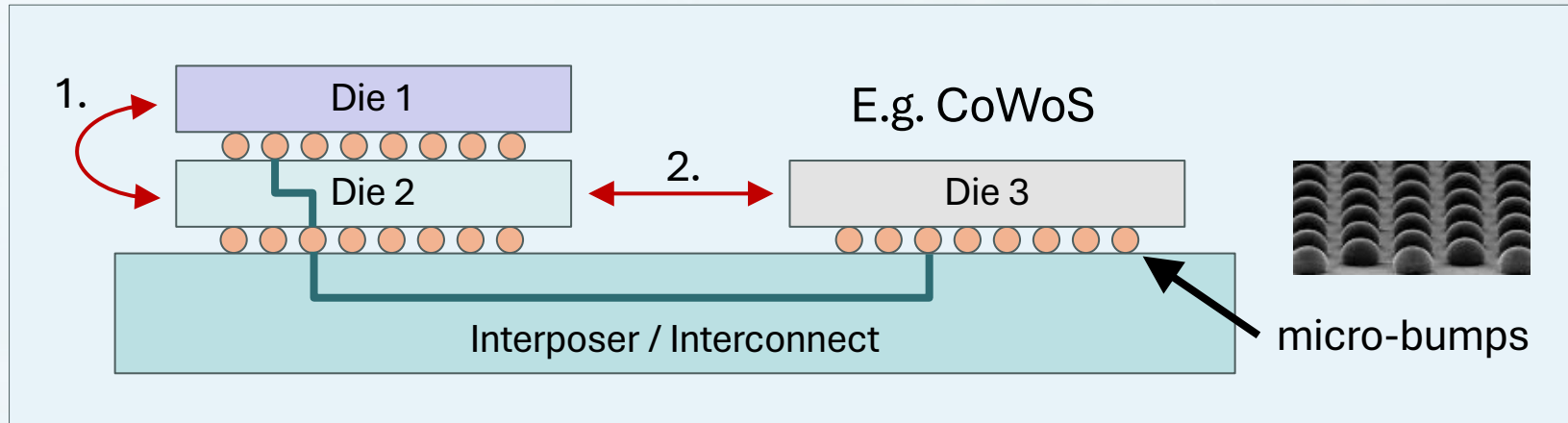


Micro-bumps testing
Enabling ultra-fine micro-bump testing



MicroLED EL testing
Massive parallel, non-invasive test for ultra-fine pitch microLED

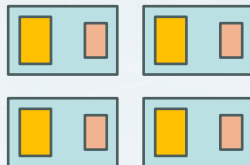
Next frontier: micro-bumps



MicroLED case:

Two pads

→ Minimum two probes

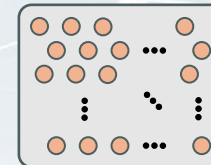


Linear array:
Cantilever probes OK

Micro-bumps case:

~100-10k micro-bumps

→ Several contacts simultaneously

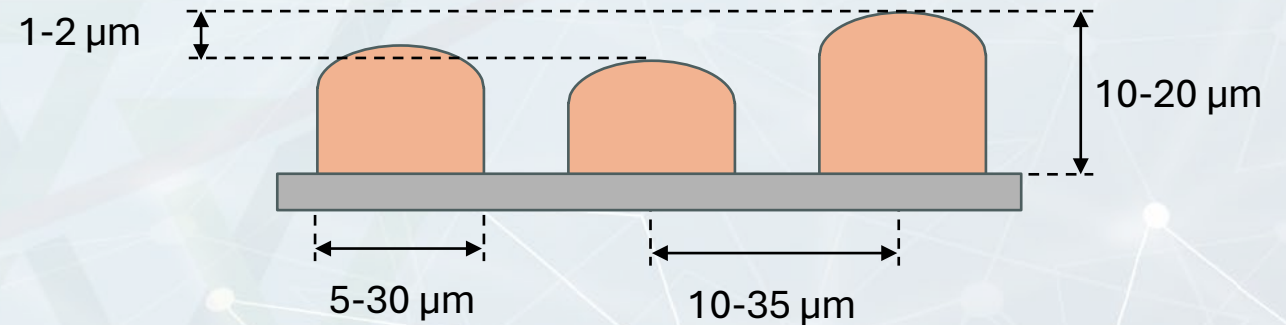


Two-dimensional array:
Vertical probes needed

The micro-bumps challenges

Major Challenges

- Ultra-fine pitch
- Extreme I/O density
- Micro-bumps height variation
- Copper / tin (oxide and soft)
- No pad damage
- Planarity & alignment



AI/HPC and advanced packaging push probing technologies to their physical and scalability limits

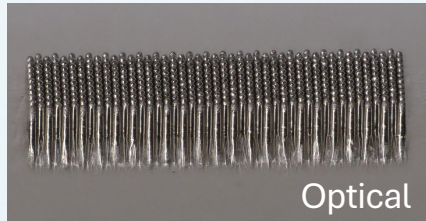
Micro-bumps test: two approaches

Stiff vertical probes

45 μm pitch

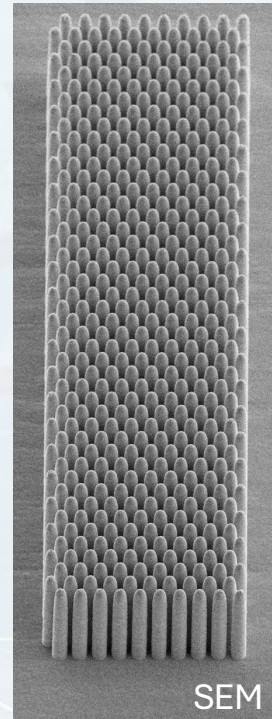


25 μm pitch



450 probes

10 μm pitch



Global mechanical action only

Compliant vertical probes

Micro-bump

Probe head

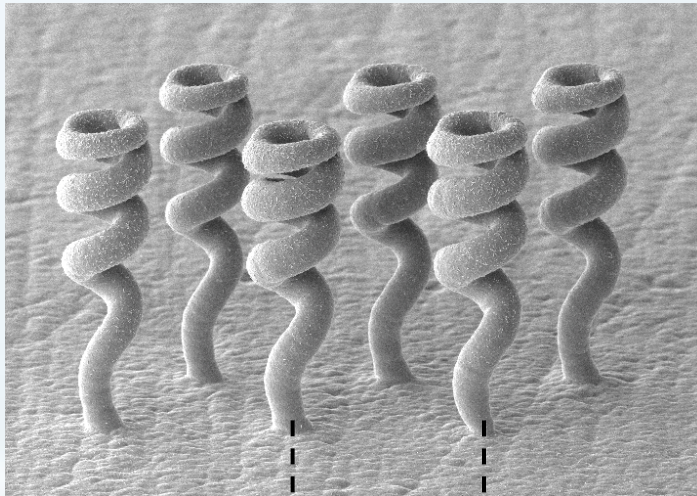
Probe
micro-spring

DUT

Compensate micro-bump variations

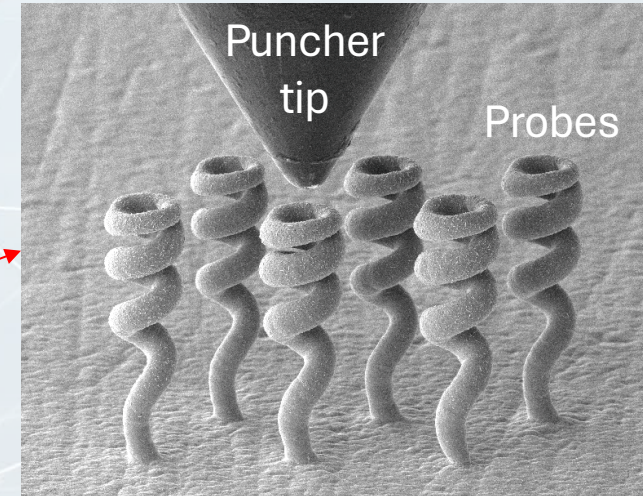
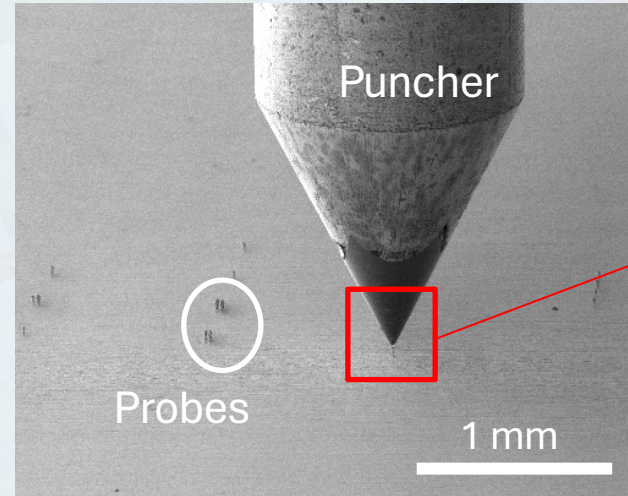
Micro-springs

Design & manufacturing
(μ 3D printing + Plating)



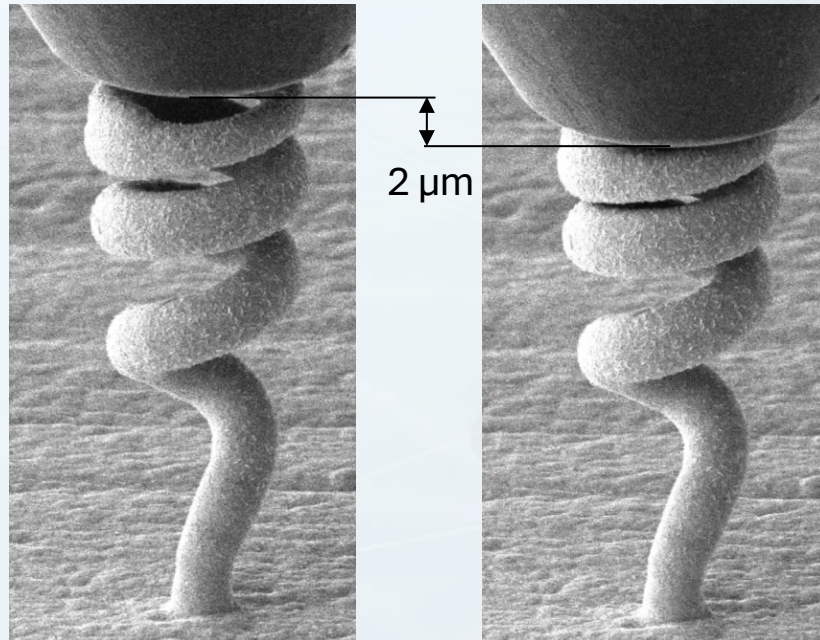
30 μ m

Validating
(Nano-indenter tests)

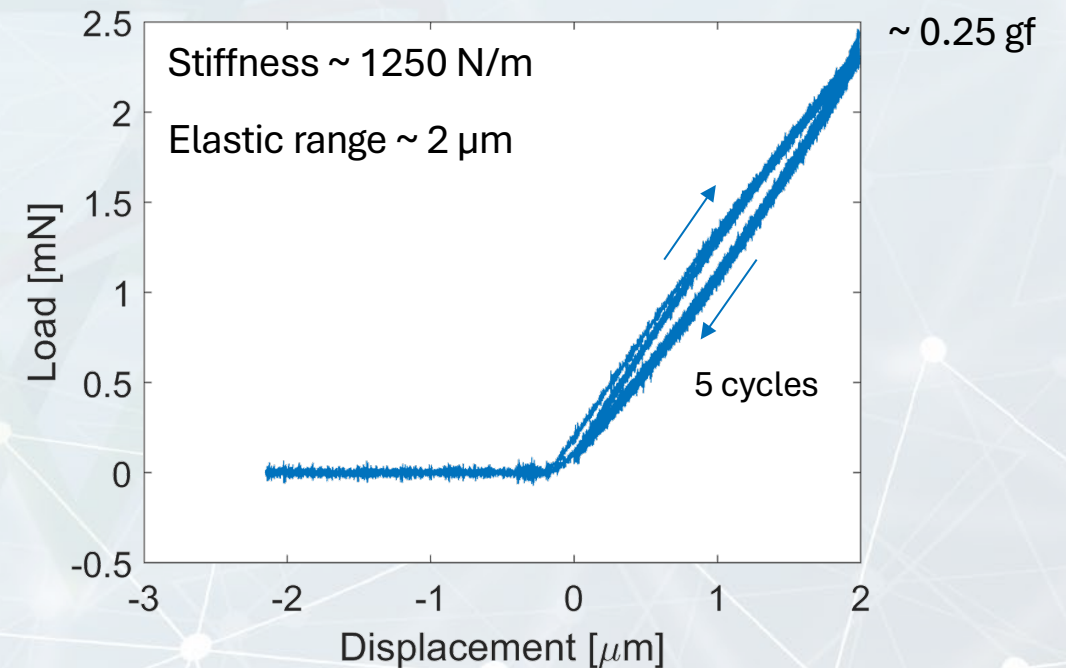


Micro-spring probes: mechanics

Probe micro-mechanics



Force vs displacement

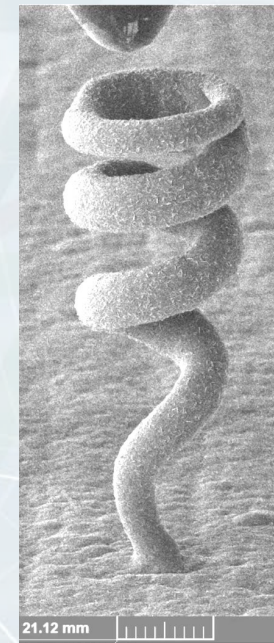
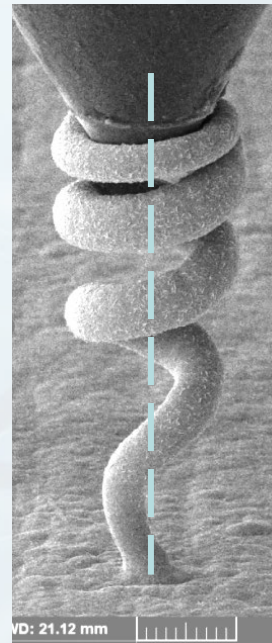
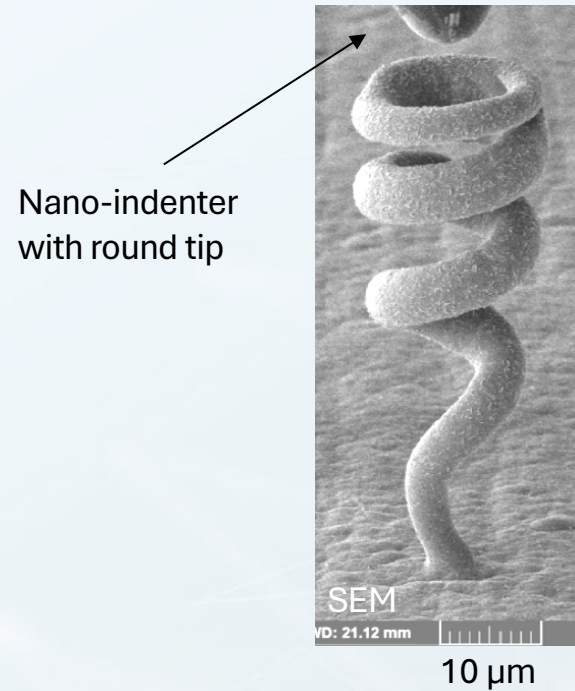


Controlled vertical compliance enabling reliable engagement with micro-bumps

Micro-bump probing simulation

Perfect alignment

Alignment offset: 3 μm

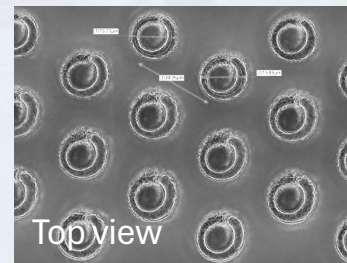
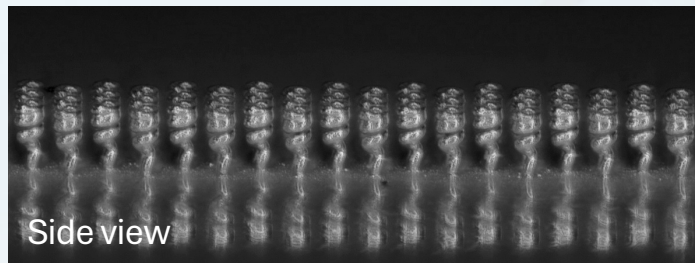
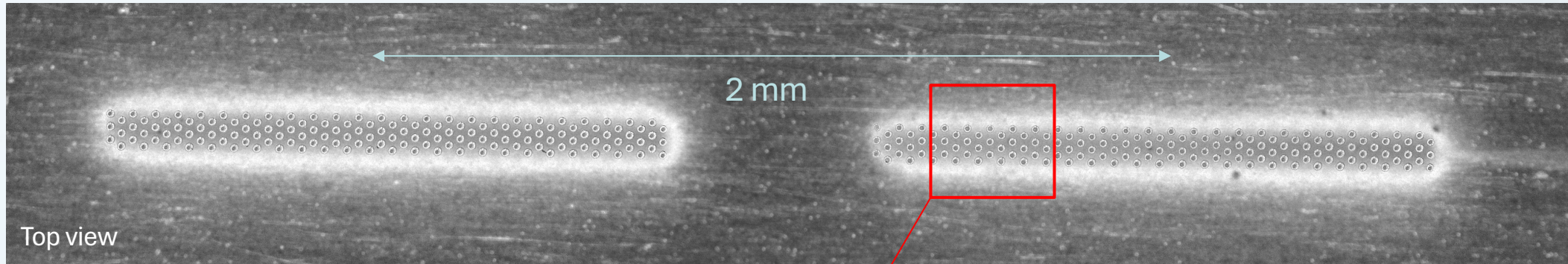


Micro-springs can bend laterally

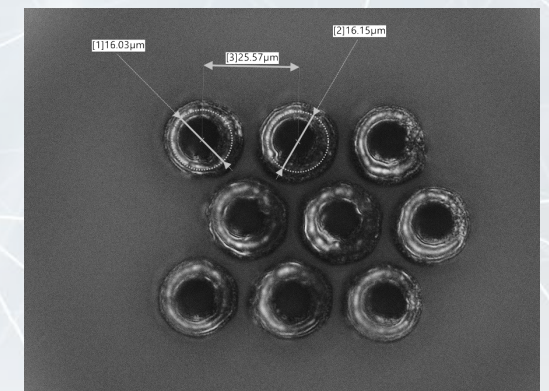
Multiple points of physical contact: load distribution + enhanced electrical contact
Self-alignment

Micro-spring scaling

Array fabrication: 300 units



25 μ m pitch micro-springs



Preliminary results

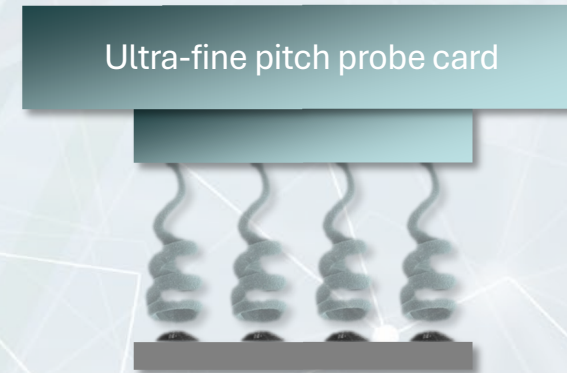


Demonstration of large high-density 2D arrays of vertically compliant probes

Outlook

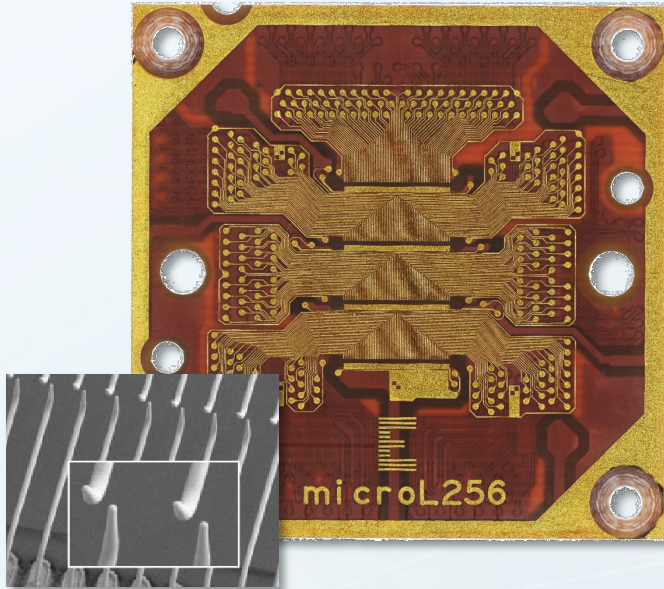
Next steps

- Electromechanical characterization
- Improve resilience and durability
- Expand probe count
- Transfer array onto interposer
- Probe card integration
- Validate on real micro-bumps

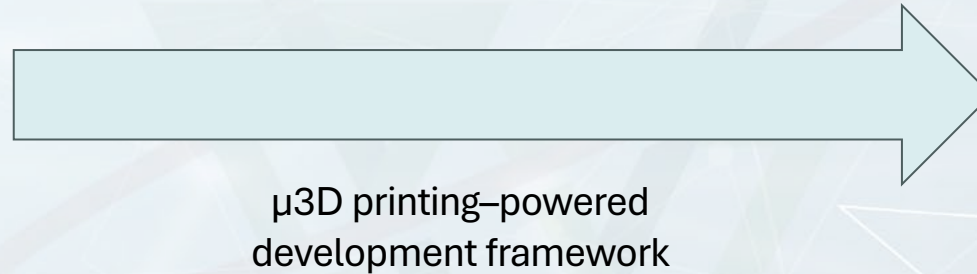
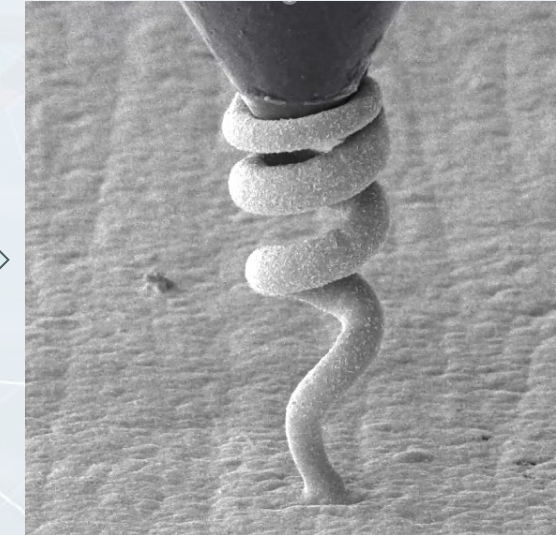


A framework for ultra-fine pitch

MicroLED testing



Micro-bumps (AI, HPC...)



One platform enabling the future of ultra-fine pitch wafer test

Conclusions

- Resolving the contact dilemma through a closed-loop, μ 3D printing-enabled framework
- Demonstrated state-of-the-art probe card for microLED testing
- Foundational work for ultra-fine pitch micro-bumps probing

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